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GENERATION AND EVALUATION OF NOVEL PRODUCT CONCEPTS VIA ANALYSIS OF EXPERIENCED USERS

Eric von Hippel

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WP # 1476-83

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GENERATION AND EVALUATION OF NOVEL PRODUCT CONCEPTS
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ABSTRACT

Multiattribute and multidimensional marketing research techniques are currently constrained to the generation and evaluation of novel product concepts which are, in the main, minor variations on existing products. We explore a major cause of this constraint - the inability of users to accurately assess novel product attributes and concepts without real-life experience with these. We then propose a solution: identification and analysis of segments of the user population who do have real-world experience with novel product concept or attributes of interest. Two categories of experienced users, "lead" users (useful for "need forecasting")and "high need" users (sources of especially rich need data), are defined and discussed as examples of the utility of the solution proposed.

Generation and Evaluation of Novel Product Concepts Via Analysis of Experienced Users

INTRODUCTION

During the past decade, there has been a vast improvement in quantitative marketing research methods for the generation and evaluation of novel product concepts. Significant among these are perceptual mapping and conjoint analysis, which have virtually become standard operating procedure among major producers of frequently purchased consumer products and services.

The new methodologies are clearly welcome: A wealth of research on the innovation process has made it clear that accurate perception of user need is critical to successful new product development (1). At the same time, this growing effectiveness and acceptance should make us focus with concern on a critical limitation pointed out by scholars involved with method development: The methods are currently effective only for the identification and evaluation of new product opportunities which involve minor variations on existing products. Thus Shocker and Srinivasan, in a critical review, assessed extant multiattribute approaches to product concept generation and evaluation as fitting within a common framework which they judged to be "...primarily useful

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for locating 'new' product opportunities which may not be substantially different from current alternatives" (2). Similarly but more specifically, Silk and Urban concluded that their own very successful model for pre-test-market evaluation of new packaged goods, ASSESSOR, was "...limited to situations in which the new brand seeks to penetrate a product category well-defined in terms of the nature and closeness of substitutes. Cases in which a very novel or innovative offering effectively creates a new product category cannot be handled by these methods" (3).

Clearly, it is important to extend the reach of sophisticated marketing research techniques to the identification and evaluation of "substantially different" product concepts - and in the present paper we consider how this might be done. We begin by exploring why the techniques are currently limited, and propose that the constraint lies not with the techniques themselves, but rather with the nature of the input data currently provided them. Next, we review a frequently proposed solution to the problem - evaluation of novel product concepts by users not fully familiar with them - and we show that this approach is unlikely to be effective. We then propose an experienced user approach - evaluation of new product concepts and attributes of interest by user segments who do have real-world experience with these. We illustrate the utility of segmenting users on a real-world experience basis by two examples: "lead users" whose needs today foreshadow general demand tomorrow and who therefore can bring a "need forecasting" dimension to marketing research; and "high need users" who will obtain such high benefit from a potential innovation that they have thought carefully about their need and can provide rich related data to receptive market researchers. Finally, we suggest problems for future research.

STATE OF THE ART

"Multiattribute" (multidimensional) marketing research methods describe a consumer's perception of new and existing products in terms of a number of attributes (dimensions). If and as a complete list of attributes is available for a given product category, a consumer's perception of any particular product in the category can be expressed in terms of the amount of each attribute the consumer perceives it to contain, and the difference between any two products in the category can be expressed as the difference in their attribute profiles. Similarly, consumer preferences for existing and proposed products in a category can in principle be built up from consumer perceptions of the importance and desirability of each of the component product attributes.

Scholars' concern that multiattribute techniques can only provide accurate perception and preference data for minor variations on existing products have two primary bases (2, 3). First, it is unclear that one can identify all product attributes potentially relevant to a product category - especially attributes which are currently not present in any extant category member. Second, it is unclear that consumers can accurately evaluate novel product concepts, novel product attributes, or "amounts" of familiar product attributes which lie outside the range of their real-world experience.

If these concerns are well-founded, then multiattribute techniques are indeed restricted to identification and evaluation of "new" product opportunities which consist of nonradical variations in the amount of those attributes already present in existing products.

Let us therefore explore the matter further and consider, first, whether present methods can identify all attributes potentially relevant to a product category, and, second, whether consumers can be expected to accurately evaluate attributes which are unfamiliar to them in either kind or amount.

Identification of All Relevant Attributes?

Methods to identify product attributes or underlying perceptual dimensions important to consumers have no in-built mechanisms to ensure that all attributes relevant to a product type under consideration are found. Consider two types of such methods: similarity-dissimilarity ranking and focus groups.

In similarity-dissimilarity methods, data regarding the perceptual dimensions by which consumers characterize a product category is generated by inviting a sample of consumers to compare products in that category and assess their similarity-dissimilarity. In some variants of the method (e.g., the "repertory grid" (4)) the consumer specifies the ways in which the products are similar or different. In others, the consumer simply provides similarity and difference rankings, and the market analyst determines - via his personal knowledge of the product type in question, its function, the marketplace, the consumer, etc. - the important perceptual dimensions which "must" be motivating the consumer rankings obtained.

This type of method has no completeness check and, clearly, depends heavily on an analyst's ability to interpret the data and characterize the critical dimensions. Moreover, by its nature, the similarity-dissimilarity method can only explore perceptions derived from attributes which exist in or are associated with the products being compared. Thus, if a group of consumer-evaluators is invited to compare a set of cameras and none in the set has a particular feature - say, instant developing - then the possible utility of this feature would not be incorporated in the perceptual dimensions generated. (E.g., the method would have been blind to the possible value of instant developing prior to Edwin Land's invention of the Polaroid camera.)

In focus group methods, market analysts assemble a group of consumers familiar with a product category for a qualitative discussion of perhaps two hours' duration. The topic for the focus group is set by the analyst and may be relatively narrow (e.g., "35 mm amateur cameras") or somewhat broader (e.g., "the photographic experience as you see it"). The discussion is recorded, transcribed, and later reviewed by the analyst whose task is to identify the important product attributes which have implicitly or explicitly surfaced during the conversation. Related techniques include "depth interviews," in which analysts hold discussions similar to those carried out in focus groups, but with only one interviewee at a session.

Clearly, as with similarity-dissimilarity ranking, focus group methods depend heavily on the ability of the analyst to accurately and completely abstract the attributes which consumers feel important in products from interview data. Just as clearly, however, the focus group technique need not be constrained to only identifying attributes already present in existing products - even if the discussion is nominally focused on these. For example, a topic which extends the boundaries of discussion beyond a given product to a larger framework could identify attributes not present in any extant product in a category under study. For example, the broad topic mentioned earlier - "the photographic experience as you see it" - embraces the development process as well as use of the camera. If discussion of the topic brought out consumer dissatisfaction with the time lag between picture taking and receipt of the finished photograph, the analyst would be in possession of information which could induce him to identify an attribute not present in any extant camera prior to Land's invention - instant film development - as a novel and potentially important attribute of cameras.

But how likely is it that an analyst will take this creative step? And, more generally, how likely is it that either method discussed above - similarity-dissimilarity ranking or focus groups - will be used to identify attributes not present in extant products of the type being studied - much less a complete list of all relevant attributes? Neither method contains an effective mechanism to encourage this outcome, and our discussions with practitioners indicate that in present-day practice, identification of any novel attribute is unlikely.

Finally, consider that both methods conventionally focus on familiar product categories. This restriction - necessary to limit the number of attributes which "completely describe" a product type to a manageable number - also tends to restrict consumer perceptions to attributes which fit products within the framed existing product categories. As an example, consider modes of transportation. These logically shade off into communication products as partial substitutes ("I can drive over to talk to him - or I can phone"), into housing and entertainment products ("We can buy a summer house - or go camping in my recreational vehicle"), indeed, into many other of life's activities. But, since one cannot compress a complete description of life into 25 attribute scales, one constrains the analysis to a narrower - usually conventional and familiar - product category or topic. This has the effect of rendering any promising and novel cross-category new product attributes less visible or invisible to the methods we have discussed.

In sum, then, neither similarity-dissimilarity rankings nor focus group methods - nor any other type of method for specifying perceptual attributes or dimensions we are aware of - have the ability to provide a complete set of relevant product attributes to market researchers interested in the development of "substantially new" products.

Generation and Evaluation of Novel Product Concepts by "Typical" Users

Scholars concerned with the limitations we have described in the previous section have proposed that consumer evaluators be introduced to novel product concepts ("stretcher concepts") (2, 5), as a means of inducing them to identify and evaluate new and possibly important product attributes or perceptual dimensions. Clearly, this approach will only work if consumers familiar with existing products and uses can accurately evaluate novel product attributes or concepts they may be introduced to. So let us assess the available evidence on this matter.

It appears that users have only a poor ability to identify (accurately characterize) or accurately evaluate novel products or product attributes which they have not experienced in real life. This is so because the marketing researcher who asks a consumer to perform these tasks is posing a difficult problem-solving task to an individual whose mind-set militates against his performing it in a creative way. Let me elaborate. First, consider that individual products are only components in larger usage patterns which may involve many products. (For example, a hi-fi tape player is used with tapes and with other hi-fi components and must be compatible with these - and with the typical living room environment as well. Similarly, a computer's characteristics must be compatible with the type of problems being solved, the types of software being used and so forth.) As a consequence, it should be clear that a change in one component in a multiproduct usage pattern can change perceptions of - and needs for - some or all other products participating in that pattern. Thus, the development of new tape materials - or new living room designs - may well necessitate changes in desired tape player attributes. And, similarly a change in the operating characteristics of a computer may mandate related changes in the attributes of software used with that computer. Next, consider that a consumer asked to consider the impact of, for example, making a computer inexpensive and easy to use (e.g., the personal computer) must first identify which of his existing usage patterns it would make sense to incorporate the personal computer in, and how he would evaluate its role in these. Then, he must invent or select the new (to him) usage patterns which the personal computer makes possible for the first time, and evaluate them. Finally, since substitutes exist for many of the usage patterns he has been considering (e.g., he has many forms of entertainment available in addition to computer games), he must estimate how the new possibilities presented by the personal computer will compete (or fail to compete) with his existing options.

The problem-solving task just described is clearly a very difficult one. Conceivably some could solve it, but studies of problem solving suggest that average users of existing products - the type of consumer evaluators usually chosen - are a group very poorly situated in this regard. In essence, a very strong finding of research into problem solving is that familiarity with existing product attributes and uses interferes with being able to conceive of a novel attributes and uses when invited to do so. Consider the studies summarized in Table 1. We

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Insert Table 1 Here

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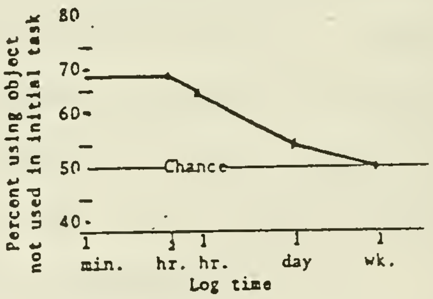
see that experimental subjects familiar with a complicated problem-solving strategy are unlikely to devise a simpler one when this is appropriate (6). Also - and very germane to our present discussion - we see that subjects who use an object in a familiar way, or see it used in a familiar way, are strongly blocked from using that object in a novel way (7, 8, 9). (Interestingly, this blocking effect seems to decrease with the passage of time since the "last familiar use" (10).) Finally, we see the same effect displayed in the real world, where the success of a research group in solving a new problem is shown to depend on whether solutions it has used in the past will fit that new problem (11).

What are the implications of these findings for marketing research methods based on the insights and judgments of consumers versed in familiar products and product uses? Such consumers are unlikely to generate novel product concepts or attributes which conflict with the familiar. Also, they are likely to evaluate any novelty presented to them in terms of the familiar, and thus introduce inaccuracy into the marketing research analysis.

Study	Nature of Research	Impact of Prior Experience on Ability to Solve Problems
Luchins (6)	Two groups of subjects (n=) were given a series of problems involving water jars, e.g.: 'If you have jars of capacity A, B and C how can you pour water from one to the other so as to arrive at amount D?' Subject group 1 was given 5 problems soluble by formula, B-A-2C=D. Next, both groups were given problems solvable by that formula or by a simpler one (e.g. B-C=D).	81% of experimental subjects who had previously learned a complex solution to a problem type applied it to cases where a simple solution would do. No control group subjects did so (p=NA[a])
Duncker (7)	The ability to use familiar objects in an unfamiliar way was tested by creating 5 problems which could only be solved by that means. (For example, one problem could be solved only if subjects bent a paperclip provided them and used it as a hook). Subjects were divided into two groups. One group of problem-solvers saw the crucial object being used in a familiar way (e.g. the paperclip holding papers), the other did not (e.g. the paper clip was simply lying on a table unused).	Subjects were much more likely to solve problems requiring the use of familiar objects (e.g. paperclips) in unfamiliar ways (e.g. bent into hooks) if they had not been shown the familiar use just prior to their problem-solving attempt. Duncker called this effect "functional fixedness" (n=14; p=NA[a])
Birch and Rabinowitz (8)	Replication of Duncker, above	Duncker's findings confirmed (n=25; p<.05)
Adamson (9)	Replication of Duncker, above	Duncker's findings confirmed (n=57; p<.01)
Adamson and Taylor (10)	The variation of "functional fixedness" with time was observed by the following procedure. First, subjects were allowed to use a familiar object in a familiar way. Next, varying amounts of time were allowed to elapse before subjects were invited to solve a problem by using the object in an unfamiliar way.	If a subject uses an object in a familiar way, he is partially blocked from using it in a novel way. (n-32; p<.02) This blocking effect decreases over time (see graph) Functional fixedness as a function of log time 
Allen and Marquis (11)	Government agencies often buy R&D services via a "Request for Proposal" (RFP) which states the problem to be solved. Interested bidders respond with Proposals which outline their planned solutions to the problem and its component tasks. In this research, relative success of eight bidders approaches to the component tasks contained in 2 RFP's was judged by the Agency buying the research (n=26). Success was then compared to prior research experience of bidding laboratories	Bidders were significantly more likely to propose a successful task approach if they had prior experience with that approach only, rather then prior experience with inappropriate approaches only. (n= ;p)

Notes: [a] This relatively early study showed a strong effect but did not provide a significance calculation - or present data in a form which would allow one to be determined without ambiguity.

Table 1: The effect of prior experience on users' ability to generate or evaluate novel product possibilities

GENERATION AND EVALUATION OF NOVEL PRODUCT CONCEPTS VIA EXPERIENCED USER SEGMENTATION

If accurate specification of needs and accurate assessment of the desirability of new products with unfamiliar attributes require real-life experience with these, a solution to the problem we have been discussing presents itself: I propose that we identify segments of the user community who do have real-life experience with novel attributes and/or product concepts of interest, and incorporate these segments into our multiattribute market research analyses. Possibly there are many specialized user segmentation schemes which can be used to this end - but currently I can propose only two generally useful ones, which for convenience I term "lead" users and "high need" users. As we will discuss, lead users will be found useful in "need forecasting", and high need users can provide data on present needs which is in important ways richer than that obtainable from average users.

Need Forecasting via Lead Users

Need forecasting is the ability to precisely predict profitable new product opportunities - so that responsive new products may be designed in a timely fashion. Two factors indicate the potential real-world importance of need forecasting. First, driven by rapid changes in factor prices, technologies and the like, significant new product opportunities can emerge rapidly - often within the time period of a few years typically required for the new product development cycle. Second, careful empirical research has shown significant and long-lasting benefit in market share and profit is often associated with being first to market with novel consumer (12) and industrial

(1,13) products. Therefore, firms which forecast needs for new products accurately will often have a significant commercial advantage over firms content to respond only to current market opportunities.

Clearly, today's average user of today's products has no experience with tommorrow's products - and thus, by the reasoning provided earlier, is in a poor position to provide accurate data regarding these to users of multiattribute market research methods. I propose, however, that segments of users whom I term "lead users" do have such experience and that these can be used by marketing researchers to obtain accurate "need forecasting" data regarding future new product needs.

"Lead users" are individuals or firms who have needs which are not now general among users of a given product - but which can be predicted to become general and provide a commercially interesting marketplace in the future. Thus, firms needing automated offices today in ways which office automation manufacturers will find it profitable to respond to tomorrow are lead users of office automation. Similarly, individual consumers seeking to apply personal computers in ways which a profitable market segment will find attractive in the future are lead users of personal computers.

Insert Figure 1 Here

Profitable new product opportunities are constantly created - and destroyed - as a function of changes in factor prices, states of technology, consumer tastes, the state of the economy and many other

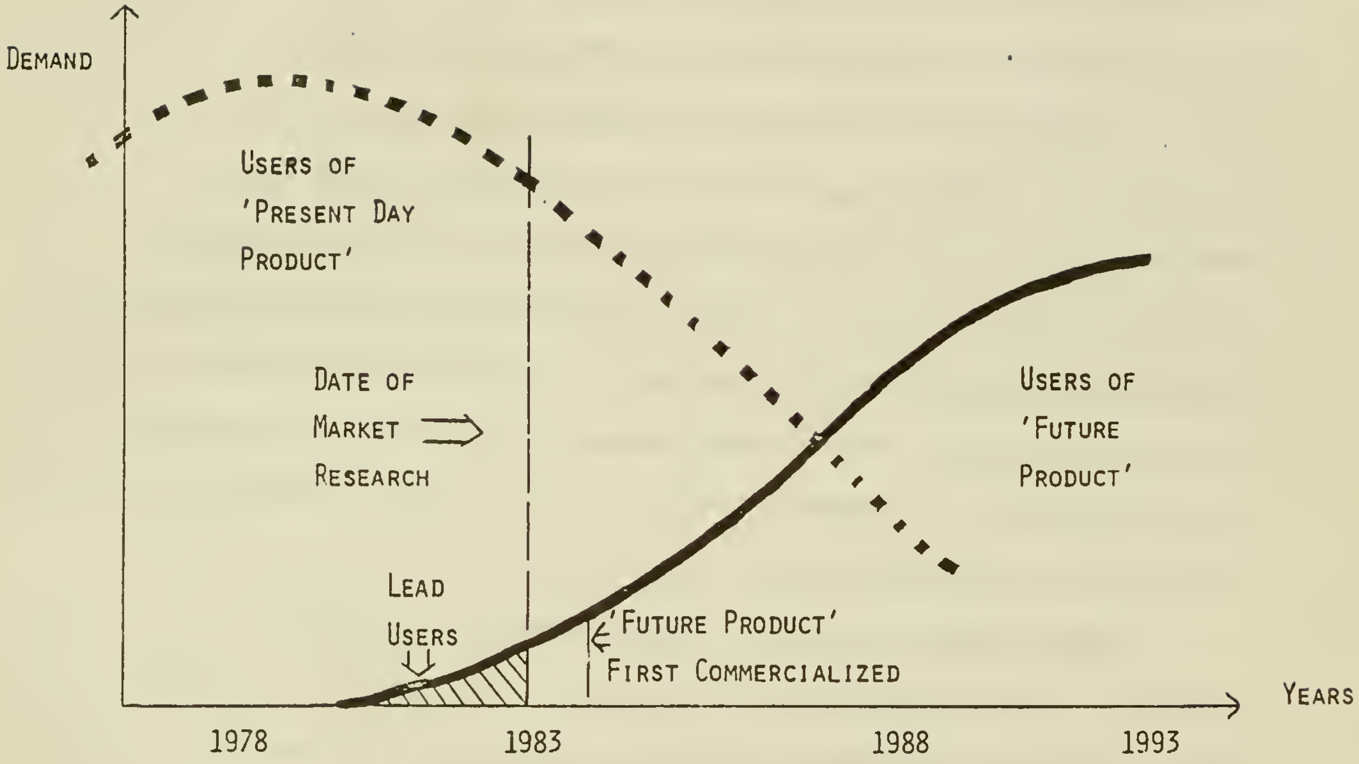


Figure 1. Market Researchers Study Users of Present Products to Understand Future Product Needs - But Should Focus on "Lead Users" Instead

factors. Thus, high-priced oil "created" the U.S. market for energy-efficient cars; advances in microelectronics and medicine will someday create the market for implantable mainframe computers; changes in consumer tastes will probably someday eliminate the market for lemon-scented cleaning products. Since forecasts regarding these causal factors are currently exogenous to consumer perception and preference techniques, our first step in utilizing lead users for need forecasting must be to forecast relevant trends and identify future attractive markets. Only then can we proceed to identify users whose present needs appear similar to those of customers in such markets. These lead user segments (who, as we will see, need not themselves be potential members of the marketplace whose needs they are simulating) are then the source of need data regarding future new product and service opportunities. Note that the analysis proceeds from the macro to the micro: It begins by identifying promising markets and ends by identifying promising specific product opportunities.

Identification of promising future markets is a necessary component of a firm's corporate strategy effort and commonly performed. Methods used range from simple trend extrapolation to more complex correlational or econometric models to the more intuitive analyses of experts, perhaps systematized in some technique like the Delphi method (14). We will not review these methods here, but two brief examples of the output of such market forecasts will prove useful in our further discussions. First, consider the general outcome of a forecast developed by a semiconductor process equipment manufacturing firm. The firm identified two major trends which it felt important to its future business: it observed that silicon was approaching certain physical limits as a substrate for semiconductor manufacture (and deduced that gallium arsenide would be the substrate material of the future); it observed a strong trend over time to the production of semiconductors with ever smaller, ever more closely spaced circuit elements on them. Both of these trends, if they continued, would clearly give rise to the need for new process machines in the not-too-distant future. As a second, less abstruse example, consider the computer firm which analyzed computer performance and cost trends in the early 1970's and concluded that a personal computer would soon be technically feasible. But the firm did not know whether there would be a market for the personal computer. Would consumers need it? What would they do with it? Note that - although both of these forecasts have major implications for the types of products which customers will need in the future - the exact nature of the new product needs and opportunities are only made visible as a result of the second stage of the analysis - the identification and interviewing of lead users.

Once a promising new market or strong trend has been identified which a firm judges should involve promising new product opportunities, the market researcher can begin to search for lead users who face "tomorrow's needs today". Why should such lead users exist? Lead users exist because important new technologies, products, tastes and other factors related to the new product opportunities typically diffuse through a society - often over many years - rather than impact all members simultaneously. Thus, Edwin Mansfield has explored the rate of diffusion of twelve very important industrial good innovations into major firms in the bituminous coal, iron and steel, brewing and railroad industries, and railroad industries - and found that in 75% of these cases it took over twenty years for complete diffusion of these innovations to major firms (15).

The search for specific lead users involves the exercise of judgment and ingenuity on the part of the market analyst. In effect, he is scanning the environment for user groups which in his estimation face conditions today which are closely analogous to those predicted to be general in the consumer market of interest tomorrow. A similar task is performed by market analysts scanning the environment for likely customers for proposed any substantially new products - but it is not necessarily a simple one. Indeed, in the instance of lead user identification, the relevant user groups may not even be within the usual customer base of the interested manufacturer. (For example, improvement of the reliability of fasteners is an important trend in the field of auto design. Manufacturers of automotive fastening products, however, consistently find their lead users in the aerospace industry-who today face fastener reliability requirements which the auto industry will face in the future.)

While we cannot provide a precise formula, we can illustrate the lead user identification task by referring back to the semiconductor equipment and personal computer examples provided just above. In the instance of the semiconductor equipment firm, market analysts would seek relevant lead users among those few semiconductor equipment user firms whose products currently face the barriers which gallium arsenide and/or higher density can solve. The identity of these may be opaque to outsiders, but would be quite clear to industry experts. (Thus, need for equipment which can fabricate chips of higher density is usually felt first by manufacturers of VLSI computer memory chips such as the 256K Random Access Memories which have been much in the news lately. Later, the need spreads to other customers such as the manufacturers of linear integrated circuits.) In the instance of personal computers, the early 1970's - a time period in which such computers were not yet technically feasible, but could be predicted - market analysts might have found one useful lead user group to be college students at major universities. At that time these students had access to something functionally quite similar to the personal computer - the time-sharing terminals linked to large university computers. (Had this group been studied in the early 1970's the popularity of computer games among teenage personal computer users in the 1980's would have been seen forshadowed: Student bootlegging of expensive computer time to develop and play computer games was known to despairing college deans nationwide (16).) A second lead user group for a likely market segment, professionals working at home, was also available in the early 1970's - in the form of the many of professionals who had minicomputers in their homes at that time for business-related purposes.

As the illustrations just given suggest, available lead user groups will probably not be precisely similar to the users who will make up a major share of one's predicted market. Thus, the semiconductor equipment needs of semiconductor memory manufacturers may not foreshadow all future equipment needs of other semiconductor makers - they may only cast a detailed light on the increased density element of future need specifications. And, similarly, the computer game interests of teenage college students majoring in computer science may not (or may) be similar to those of other groups of teenagers and preteens. Indeed, the literature on diffusion suggests that, in general, the early adopters of a novel product or practice differ in significant ways from the bulk of the users who follow them (17). Thus, in general, analysts will need to exercise care in interpreting lead user data.

In specific instances, strategies may be available to verify the commercial attractiveness of new product concepts generated by lead users. For example, verification via studies of typical present-day users may be possible if a firm can prototype a product containing novel attributes economically enough to allow one to present it to a sample of "typical users" representative of the bulk of one's future market. After using the product, such users would be in a position to provide accurate product evaluation data to market research _if_ (a) presenting the user with the product created conditions for him similar to the conditions a future user would face, and _if_ (b) the user were given enough time to fully explore the new product and fully adapt his usage patterns to it. If a new product were being tested in a field where little else was expected to change by the time of product introduction - say, a new detergent for the home laundry - conditions (a) and (b) might be easily met. One is less likely, however, to be able to create accurate lead user conditions in rapidly moving fields in which the proposed new product will interact with many other not-yet-developed products in unforeseen ways. New approaches may be needed here.

Rich Need - and Solution - Data from High Need Users

"High need users" are individuals - or firms, in the instance of industrial goods - who have a significantly _stronger need_ for a given novel or familiar product attribute or product concept than does the average user. (Thus, race car drivers have a higher need for some aspects of auto performance than do ordinary drivers - and are therefore high need users with respect to those aspects.)

Since problem-solving activity has been shown to be motivated by expectation economic of benefit, at least in industrial goods,* we reason that high need users will be motivated by their relatively strong needs to devote effort to understanding and perhaps experimenting with how to solve the need at issue. This in turn leads to a relatively rich and elaborated real-world understanding of the need which can be explored by appropriate market research. Possibly, as we will see, it results in the development of novel and useful new product concepts as well.

The idea of users having useful "solution data" of potential interest to market researchers is currently a somewhat alien one, we find. "Marketing research is about needs, not solutions", we have often been told. Really, however, all need statements implicitly or explicitly contain more or less information about possible solutions to the need. Consider the following sequence of need statements, each addressing the same need but each containing more solution content than the one preceding:

- "I am unhappy ...
- about my children's clothes ...
- which are often not fully clean even when just washed.
- I find that X type of stains on Y type clothes are especially hard to remove
- If I mix my powdered detergent into a paste and apply it to the stain before washing, I find it helps get things clean.

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*The link between high innovation benefit and industrial good innovation activity levels has been clearly established by Jacob Schmookler, who conducted a careful empirical study of the correlation between changes in sales volumes of some capital goods and appropriately lagged changes in rates of patent applications in categories related to those goods (18).

Note that the later statements have useful solution content - both specifically (one could invent liquid detergent on the basis of the last statement) and also about the type of solution the high need user prefers. Thus, we see that the user is approaching the problem as a "stain removal" problem rather than a "keep the kids away from X staining agent" problem. And, probably, the consumer is ranking this choice after having experimented with both approaches. In essence this experience with the need/problem is what makes high need user data - whether seen as need data or solution data - so valuable to market researchers.

Segments of high need users relevant to a given firm are identified differently in the instance of consumer and industrial goods. In the case of consumer goods, one can generally proceed by identifying the attribute one wishes to focus on and then examining a large group of users and flagging those who place a significantly higher value than most on incremental improvements in those attributes (e.g., x standard deviations above the mean).* High need users of industrial goods can be identified if we translate high need for an attribute into high firm profit derivable from product improvements in a given attribute. Then, users (firms) who will gain a high profit from advances along a given attribute dimension are high need users with aspect to that product or attribute.*

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*I am grateful to V. Srinivasan for this suggestion.

When market researchers have identified high need users in a product (attribute) area under study, they may expect to find that these users are well aware of the need and can provide rich responses to inquiry on the topic. And, as we noted earlier, they may also find that the high need users have experimented with solving their need. This problem-solving work can be explored by focus groups or other qualitative means, and will often provide useful new product concepts or even tested product designs.

Problem-solving activity by high need users may involve user application of commercially available products or components in novel ways, or it may involve user deveopment of complete new products. Anecdotal examples of the former are often published, and abbreviated accounts of two of these may help to convey the flavor:

> Since 1957, when a North Carolina trucker, Malcom McLean, discovered that he could save time and cut down on theft and breakage by hoisting his goods-laden truck rigs directly aboard ship, containerization has completely transformed the shipping industry.....

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* Practitioners should be aware that identification of high need users of industrial goods via calculation of innovation benefit is not trivial under real-world conditions. This is so because, as I have discussed at length elsewhere (19) innovation cost-benefit ratios are not immutable characteristics of particular innovations. Rather, they are the outcome of an innovating firm's energetic strivings to reduce its innovation costs and capture as much of an innovation's benefit for itself as possible - in the face of determined opposition. Thus, an innovating firm may attempt to protect its innovation from its competitors via patent or secrecy - or not; and it may be successful in these attempts - or not. Similarly, a firm might find an inexpensive way to develop an innovative process machine - or it might only conceive of costly solutions.

> Says Robert Calder, executive director of the Boston Shipping Association: "The shift from freighters to container ships is no less a revolution than the transition from the sailing ship to the steamship." (20)

Indeed, even young lead users can assemble components in novel ways which prove commercially significant:

> In the early 1970's, store owner and salesmen in southern California began to notice that youngters were fixing up their bikes to look like motorcycles, complete with imitation tailpipes and "chopper-type" handlebars. Sporting crash helmets and Honda motorcycle T-shirts, the youngers raced their fancy 20-inchers on dirt tracks. Obviously on to a good thing, the manufacturers came out with a whole new line of "motocross" models. By 1974 the motorcycle-style units accounted for 8 percent of all 20-inch bicycles shipped. Two years later half of the 3.7 million new juvenile bikes sold were out of motorcross model....(21).

As an example of user development of a complete new product, consider the following from a research study of the phenomenon:

> IBM designed and built the first printed circuit card component insertion machine of the X-Y Table type to be used in commercial production. (IBM needed the machine to insert components into printed circuit cards which were in turn incorporated into computers.) After building and testing the design inhouse, IBM, in 1959, sent engineering drawings of their design to a local

> machine builder along with an order for eight units. The machine builder completed this and subsequent orders satisfactorily, and later, in 1962, applied to IBM for permission to build essentially the same machine for sale on the open market. IBM agreed and the machine builder became the first commercial manufacturer of X-Y Table component insertion machines. (The above episode marked that firm's first entry into the component insertion equipment business. They are a major factor in the business today.) (29)

The value of new product concepts or attribute analyses generated by means of high need users to the general market may be verified much more straightforwardly than can the lead user data discussed earlier. This is because there is no time lag during which the market must catch up to insights generated by high need users: one is not predicting what the market will want in the future - one is learning more about what is wanted now. As a consequence, one may test insights generated with the aid of high need users by routine marketing research studies of users who are more representative of the market one wishes to address.

Evidence Regarding Novel Product Concepts and Attributes Obtainable from Experienced User Segments

Do we have any evidence that the proposed analyses of experienced user segments (lead users and/or high need users) will in fact yield commercially useful novel product concepts and/or attributes? Figure 2 summarizes what we have predicted will be available from these two types of experienced users. We only have data regarding cells I and II of figure 2 at this point, however, because the sources of once-novel

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Insert Figure 2 Here

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product concepts and attributes are seldom well recorded. And therefore, available retrospective studies of user-developed new product data have focused on evidence of commercially successful, significantly novel user-developed _products_ only. We have predicted that such products might well be developed by users who are high need (figure 2, cell II) or high need _and_ lead users (figure 2, cell I), and, as we shall show, available data confirms these predictions. Indeed, in some product areas studied, users are found to have developed _most_ of the commercially successful product innovations.

The studies whose results are summarized in Table 2 are based on samples of major innovations in the industrial product types noted there. The method used in each of the Table 2 studies marked with an asterisk was done by us or by students under our direction, and the methodology used in each of these is uniform. Each involved

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Insert Table 2 Here

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interviews with user's and/or manufacturer's personnel actually involved in the development of each sampled innovation as well as a review of the written record and available prototype hardware. By these means, we

		LEAD USERS	
		Yes	No
HIGH NEED USERS	Yes	I Product CONCEPT Data - Future Needs	II Product CONCEPT Data - Present Needs
	No	III Product NEED Data - Future Needs	IV Product NEED Data - Present Needs

Figure 2: Data Available from Lead and High Need Users

Study	Nature of Innovations and Sample Selection Criteria	Innovative Product Developed By:[a]			
		n	User[a]	Mfg.[a]	Other
Knight (22)	Computer innovations 1944-62:				
	- systems reaching new performance high	143	25%	75%	
	- systems with radical structural innovations (level I)	18	33%	67%	
Enos (23)	Major petroleum processing innovations	7	43%[b]	14%[b]	43%[b]
Freeman (24)	Chemical processes and process equipment available for license, 1967	810	70%	30%	
* Berger (25)	All engineering polymers developed in U.S. after 1955 with >10mm pounds produced in 1975	6	0%	100%	
* Boyden (26)	Chemical additives for plastics: All plasticizers and UV stabilizers developed post World War II for use with 4 major polymers	16	0%	100%	
*Lionetta (27)	All pultrusion processing machinery innovations first introduced commercially 1940-76 which offered users a major increment in functional utility	13	85%	15%	
* von Hippel (28)	Scientific instrument innovations:				
	- first of type (eg. first NMR)	4	100%	0%	
	- major functional improvements	44	82%	18%	
	- minor functional improvements	63	70%	30%	
* von Hippel (29)	Semiconductor and electronic subassembly manufacturing equipment:				
	- first of type used in commercial production	7	100%	0%	
	- major functional improvements	22	63%[c]	21%[c]	16%[c]
	- minor functional improvements	20	59%[c]	29%[c]	12%[c]
* VanderWerf (30)	Wirestripping and connector attachment equipment	20	11%	33%	56%[d]

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[a] NA data excluded from percentage computations.

[b] Attribute missing percentage to independent inventors/invention development companies.

[c] Attribute missing percentage to joint user-manufacturer innovation projects.

[d] Attribute to connector suppliers

Table 2: Data Regarding the Role of High Need and Lead Users In Product Development

were able to determine, in all cases coded as user-developed, that the novel product concept as well as the product hardware itself was indeed user-developed.* Data available on the type of user firm which developed the innovations studied (17) indicate that those in the best position to capture innovation benefit (e.g., largest market share) were indeed the innovating firms (further not-yet published data by the author strongly supports the preliminary data presented in (17)). Thus high need users do appear to generate commercially significant new product concepts - and designs.

Note that Table 2 shows users to be the dominant source of commercially successful products in some product types - e.g., semiconductor process machinery (29) - but not in others - e.g., engineering plastics (25) and connector attachment equipment (30). The lack of significant product development activity in a given product type does not mean that high need users with their rich insights are absent there: By definition (given a nonuniform level of need among all users) high lead users are always present. They are simply those users who have a "significantly higher" need for a given product or attribute than the mean user. Low product development by lead users in a given area simply means that the distribution of economic benefits flowing from product development in that area make product development by manufacturers or other nonuser groups so attractive that they preempt high need user development activity. After all, product development costs money and users will not do it if others will do it for them at a net saving (17).

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* Our criterion for coding a successful new product as user developed was quite strong. It was required that user-developed products be user designed, built and used successfully (e.g. commercial use on a production line in the case of process machinery; published results in the case of a scientific instrument innovation) before product manufacturer involvement (24, 25).

While no hard measures on this point were taken (the studies were oriented toward a different issue), we can also report on anecdotal interview data with user-innovators and manufacturers which indicates that many of the high need user-developed products were in fact "lead user" innovations. That is, manufacturers who eventually commercialized the user-developed products studies often reported that demand for the product was not general at the time it was developed - but later it became general. Thus, some semiconductor equipment innovations studied could only be justified by high-volume firms like IBM and Western Electric when they were developed. Approximately three to five years later, however, when these user-developed products were first commercialized by equipment manufacturers, the semiconductor market had grown so much larger that many customer firms could justify buying the high volume equipment.

In sum, then, available data supports the concept that high need users - visible retrospectively when they engage in product development work - can provide valuable inputs regarding commercially significant product concepts to marketing research. And, currently on the basis of anecdotal data only, we can report that lead users who were visible because of product development work (e.g., they were both lead users and high need users) also exist and can provide valuable inputs to marketing research regarding products which will become commercially significant.

Summary and Suggestions for Future Research

We began this paper by exploring why multiattribute marketing research techniques - and, by extension, other quantitative marketing research techniques such as multidimensional scaling - had limitations with respect to generating and evaluating "substantially new" product concepts. Having identified the major cause as the use of consumer evaluators who did not have real-world experience with the novel product concepts and attributes of potential interest, we offered the general proposition that user segments could be found and analyzed who _do_ have real-world experience with novel product concepts and attributes of commercial interest. And, more specifically, we have proposed "lead" users and "high need" users as examples of useful segmentations which would enable clearer understandings of selected product attributes outside of the normally experienced range and clearer understandings of future profitable markets respectively.

Clearly, more research is needed on the elaboration and application of these proposals. Also essential, in our view, are studies exploring the actual limits in the ability of users to accurately evaluate the unfamiliar in the specific context of marketing research practice. Findings in the problem-solving literature suggest significant limitations will be found - but how significant? And are these differences by field or topic or nature of user group?

Valuable research on these topics appears to be well within reach. For example, there are subsets of users who are and who are not familiar with certain existing products: Evaluative data generated by members of these two subsets could be economically collected and compared (31). Similarly, perceptions of lead and high need users could be experimentally compared with those of average users. The results of this research would tell us where and when to turn to evaluation of experienced user data as a means of extending multiattribute techniques to substantially new products.

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